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INTERNAL NOTE

AN EVALUATION OF TERMI-POINT CONNECTORS

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AN EVALUATION OF TERMI-POINT CONNECTORS

ABSTRACT

This report is a statistical evaluation of Termi-point connectors and their adequacy for use in ground support equipment. Tests performed included vibration, physical shock, salt spray, gas seal, thermal shock, and humidity. Suitability for the intended purpose was demonstrated.

ADVANCED METHODS AND RESEARCH SECTION
ELECTRICAL TEST AND ANALYSIS BRANCH

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SUMMARY

Termi-point connectors offer a new technique for point-to-point wiring. The wire and terminal are affixed to a terminal post by the use of a pneumatic applicator that strips the wire and makes a contact.

This report covers a series of tests designed to ascertain the adequacy of the Termi-point connectors for use in ground support equipment.

Tests performed included vibration, physical shock, thermal shock, salt spray, gas seal, and humidity.

While suitability of Termi-point terminals for usage in ground support equipment was demonstrated, it was felt that in certain critical areas and for flight conditions, that a more dynamic test program should be conducted.

I. INTRODUCTION

Termi-point connectors were introduced in 1963 by the Amp Corporation of Harrisburg, Pennsylvania. Possessing advantages including the elimination of soldering, welding, and wrapping, Termi-point connections offer a new technique of point-to-point wiring.

The purpose of this report is to evaluate a series of tests that were performed to determine the susceptibility of Termi-point connections to anticipated ground support equipment environment.

The tests, selected to give a general appraisal of overall capabilities, included vibration, physical shock, thermal shock, salt spray, gas seal, and humidity.

Prior to use in critical areas and to meet flight conditions, a more dynamic test program should be conducted on a sample of the design configuration; acceptance being contingent upon satisfactory test results.

II. DESIGN OF EXPERIMENT

Three factors were to be varied in the experiment: wire type, wire size, and terminal-clip plating material. The three wire sizes used were 22, 24, and 26. The two types of wire used were solid and stranded, and the two types of Termi-point clip and terminal post materials were gold and tin. This gave 11 degrees of freedom to the experiment.

A matrix, wherein all degrees of freedom were represented, was used in designing the test sample. This ensured that all permutations of the three factors were varied in such a way that statistical tests of significance of variation could be made when the tests were completed. A gross sample size of 66 was planned, but for the thermal shock test a double sample was used to gain an extra measure of confidence.

The following diagram shows the approach used in developing the matrix for the sample.

Diagram for Matrix

1	2	3	
Wire Type	Wire Size	Post and Clip Plating	
Stranded Solid	22 24 26	Gold Tin	
2	3	2	Degrees of Freedom

(2 x 3 x 2) - 1 = 11 Degrees of freedom

The above diagram was expanded into the sample matrix by using 6 specimens for each permutation except one wherein three specimens were used. This exception was solid no. 26 wire where lack of material required a reduction of specimens.

The statistical analysis is found in section VI.

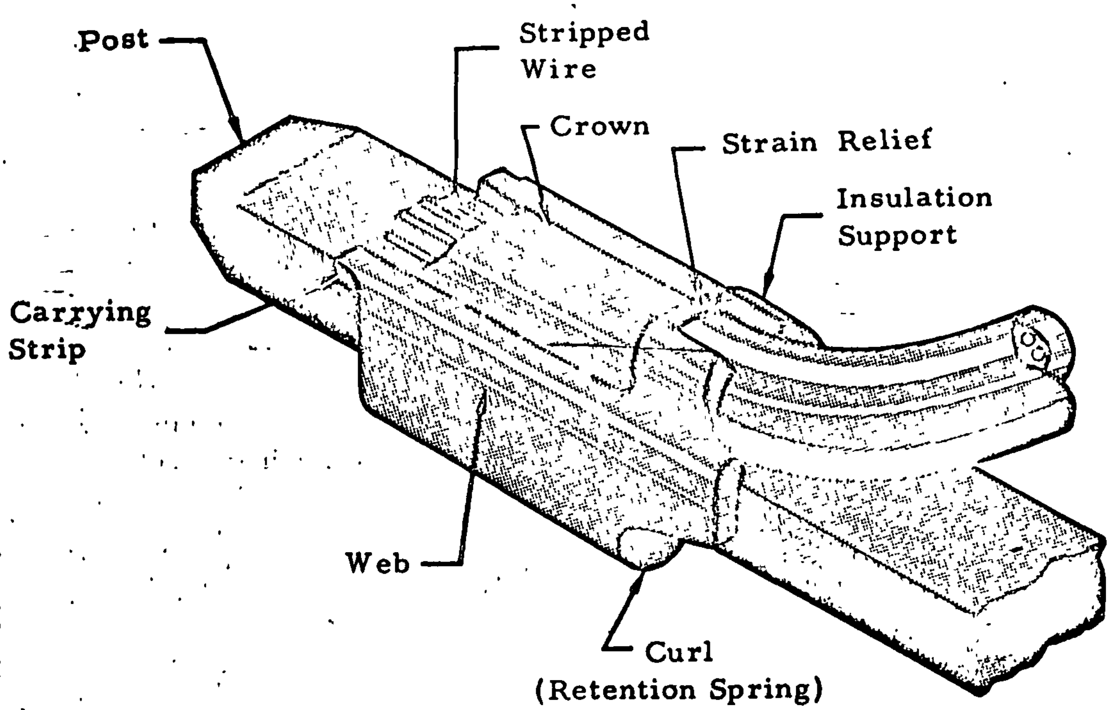
III. DESCRIPTION OF THE COMPONENT

The Termi-point connector is an electrical wire clip which consists of a web, crown, serrations, strain relief, and insulation support. (See figure 1.)

The web or body of the clip functions to press a stripped wire end against the terminal post.

The crown is the embossing of the clip web. The function of the crown is to control bundling of stranded wire during application of clip and wire to the post.

The serrations are internal cross scorings located at the clip's crown. The function of the serrations is to prevent wire slippage relative to the clip during clip application to the terminal.



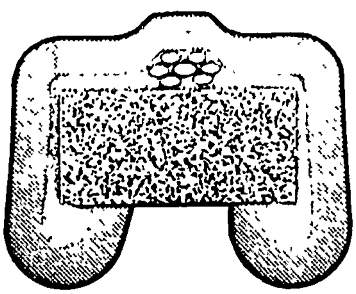


Figure 1. Termi-point Connection

The strain relief, located at the outward flange on the end of the clip web, functions to eliminate wire nicking.

The insulation support is the preformed area of the clip. The supports hold the insulation secure to prevent movement of the wire during flexing and vibration.

IV. EQUIPMENT USED IN TESTS

A brief description of the equipment used for the various tests is as follows:

1. Vibration System - M. B. Manufacturing Company oil cooled vibration platform, Model C-25HB.
   Rating - 5000 force pounds.
   Operating range - 5 to 3000 cps.
   Noise capability - 75 decibels (db) per octave from 10 to 2000 cps ±1/2 db.

2. Physical Shock - Consolidated Electrodynamics Corporation shock test machine.
   Capabilities - Imparts 1/2 sine wave force impulse of 10 g to 130 g within 8 to 13 milliseconds.
   Maximum force - 8000 pounds thrust with 100-pound specimen.

3. Thermal Shock - Tenney Engineering, Inc. Temperature Chamber, Model 36T-90600.
   Range - -73.3°C to +315.6°C
   Chamber mounted on hydraulic lift - capacity 0 to 56 inches for combined temperature vibration tests.

4. Salt Spray - Industrial Filter and Pump Manufacturing Co., Model CAS-1.
   Temperature range - +1.1°C to 48.9°C.
   Simulates environments containing 25 percent salt by weight.

5. Gas Tightness - H_2S gas cylinder - Laboratory desiccator.

6. Humidity - Tenney Engineering Inc., Model CTTUFR-100350.
Temperature range - -73.3°C to +176.7°C.
Humidity Control - 20 and 95 percent over temperature range of +1.7°C to +82.2°C.

V. DETAILED TEST PROCEDURE

A. REQUIREMENTS

1. Tolerance of Equipment. The maximum allowable tolerance on test conditions was as follows:

a.	Temperature	± 2°C
b.	Vibration Amplitude	± 10 percent
c.	Vibration Frequency	± 5 percent
d.	Shock Duration	± 1 millisecond

2. Standard Conditions. Unless otherwise specified, all tests were conducted under the following conditions:

a.	Temperature	25° ± 3°C
b.	Relative Humidity	70 percent maximum
c.	Pressure	710-810 millimeters of mercury

3. Laboratory Equipment. The following major items of equipment were required to perform the tests:

a. Vibration Table. Capable of imparting 0.06 inch double displacement from 10 to 80 cps and an acceleration of 20 g from 80 to 2000 cps.

b. Shock Machine. Capable of imparting a one half sine wave shock of 6 to 11 milliseconds duration and 125 g peak to the test specimen and associated hardware.

c. Temperature Chamber. Controllable in the ranges of 25 ± 5°C to 125 ±3°C.

d. Temperature Chamber. Controllable in the ranges of 25^{+10}_{-5}°C to -65^{+0}_{-5}°C.

e. Humidity Chamber. Capable of maintaining humidity per method 106B of Standard MIL-STD-202C.

f. Salt Spray Chamber. Capable of maintaining 20 percent salt spray environment per method 101B, Condition A, of Standard MIL-STD-202C.

4. Measuring and Recording Equipment. The following measuring and recording equipment were required:

a. Millivoltmeter - 0-2000 millivolts dc, 1 percent

b. Ammeter - 0-5 amps, 1/2 percent

c. Voltohmmeter - multirange, 5 percent

d. Oscilloscope, camera, dc power supply, recorders, and other equipment as required.

B. EVALUATION TESTS

1. Examination of Product. The connectors and all component parts were required to be mechanically stable. There could be no evidence of misaligned clips or terminal posts or loose or broken connections. Visual inspections were performed in accordance with AMP GP-1920, "Quality Control Procedure for Termi-Point Clip Application".

2. Test Sequence. The connectors were subjected to environmental testing in accordance with and in the order shown in table 1. Characteristic and mechanical tests were performed before and after each environmental test in accordance with paragraphs D.1 and D.2.

Table 1. Environmental Test

Test Description	Test Method Para. No.	Test Failure Para. No.
a. Vibration	D. 3. a and D. 3. b	C. 2. h
b. Physical Shock	D. 3. c	C. 2. i
c. Thermal Shock	D. 3. d	C. 2. j
d. Salt Spray	D. 3. e	C. 2. k
e. Gas Seal	D. 3. f.	C. 2. l
f. Humidity	D. 3. g	C. 2. m

C. DESCRIPTION OF SPECIMEN FAILURE

1. General. Visual inspection for any damage to the connectors was performed following each environmental condition and following each test phase or whenever any deviation from normal operation was observed. Any deviation from the requirements of paragraphs B.1 and C.2 was considered a failure.

2. Definition of Failure Points.

a. Physical Damage. Any physical damage or change which prevented satisfactory operation within tolerance under the environmental conditions specified constituted a failure.

b. Irreparable Damage. Irreparable damage to structural or principal parts was defined as catastrophic failure.

c. Contact Resistance. When the connector contact resistance was measured before and after each environmental condition, any contact resistance which exceeded 800 microohms was considered a failure.

d. Contact Chatter. When the connector contacts were monitored during any physical test, any contact chatter which caused a change in the connector contact resistance of one ohm for one microsecond was considered a failure.

e. Low Level Conductivity Test. When 1 microvolt was applied across the connector contact in an open circuit, the connector was considered a failure if less than 1 milliampere of current flow was measured.

f. Connector Retention. When the connectors were tested in accordance with paragraph D.2.a, any measurement that did not meet the requirements of the following table was considered a failure.

Table 2. Minimum Clip Retention

Wire, AWG, Size Stranded, Solid	Post Finish	
	Electrotinned, Reheated After Tinned or Rolled Finish	Rolled Tin Plated, Gold Over Nickel, Gold Plate, Smooth Nickel, or Tin Nickel
26 AWG	3.0 lbs	2.25 lbs
24 AWG	3.0 lbs	2.25 lbs
22 AWG	3.0 lbs	2.25 lbs

g. Connector Stripping. When the connectors were tested in accordance with paragraph D.2.b, any measurement that did not meet the requirements of the following table was considered a failure.

Table 3. Minimum Clip Stripping

Stranded Wire Size	Method A (Second Part of the Appendix)	Method B (Second Part of the Appendix)
26 AWG	5.0 lbs	5.0 lbs
24 AWG	7.0 lbs	7.0 lbs
22 AWG	7.0 lbs	7.0 lbs

h. Vibration. Any connector that loosened, cracked, or broke, or any contact chatter which caused the contact resistance to exceed 1 ohm for 1 microsecond during test was considered a failure.

i. Physical Shock. Any connector that was physically damaged or any contact chatter which exceeded 1 ohm for 1 microsecond during test was considered a failure.

j. Thermal Shock. Any connector physical damage that resulted from the effects of the test conditions was considered a failure.

k. Salt Spray. Any visible or injurious effect to the connector finish or materials resulting from the effects of the test conditions was considered a failure.

l. Gas Seal. Any visible or injurious effects to the contact surface resulting from exposure to hydrogen sulfide fumes was considered a failure.

m. Humidity. Any evidence of damage to the connector was considered a failure.

D. DESCRIPTION OF TESTS

1. Characteristics Tests. Except as indicated below, the tests described in the following paragraphs were performed before and after subjecting the test specimen to each of the environmental tests listed in table 1.

a. Visual Inspection. The test specimen was subjected to visual examination in accordance with the requirements of paragraph B.1.

b. Contact resistance applicable to thermal shock, salt spray, gas seal, and humidity tests was determined by measuring the voltage drop across each connector contact at a test current of 0.1 ampere.

c. Contact Chatter. (Applicable to vibration and physical shock tests only.) Connector contacts were wired in series, and the connector contact chatter was monitored with 0.1 ampere flowing through the test circuit.

2. Mechanical Tests. Except for the gas seal test, the following tests were performed after each environmental test listed in table 1.

a. Connector Retention. An axial force was applied to the connector. The force was applied to the connector in the direction opposite to the force originally applied to clip the connector to the terminal post. The rate of pull was approximately 0.5 inch per second.

b. Connector Stripping. A force was applied to the connector perpendicular to the terminal post. The force was increased until the connector stripped from the terminal post. The stripping force was recorded.

3. Test Methods.

a. Sinusoidal Vibration. The test specimen was subjected to sinusoidal vibration in each of three mutually perpendicular axes. The axes were defined as follows:

X-Axis - Passes through and parallel to the connectors longest axis.
Y-Axis - Passes through and parallel to the connectors shortest axis.
Z-Axis - Passes through and perpendicular to the X and Y axis.

The vibration cycle consisted of simple harmonic motion over a range from 10 to 2000 to 10 cps in approximately 20 minutes. This cycle was performed three times in each major axis. The rate of change of frequency was varied logarithmically. The vibration levels were as follows:

10 to 80 cps at .06 inch double amplitude (da) displacement
80 to 2000 cps at 20 g

b. Random Vibration. The connectors were subjected to 2 minutes of random vibration on each of the test specimen's three mutually perpendicular axes (paragraph D.3.a). An average 21.1 root mean square (rms) g force was maintained during testing in each axis. The random noise broadband power density pattern was as follows:

From 16 cps to 64 cps @ $\frac{0.093\,g^2}{\text{cps}}$

From 64 cps to 500 cps @ $\frac{0.36\ g^2}{cps}$

From 500 cps t 2000 cps @ $\frac{0.36\ g^2}{cps}$ linearly decreasing

to $\frac{0.029}{cps}$

Pattern equalization was ± 3 db.

c. Physical Shock. The connectors were subjected to impact shock tests in accordance with Standard MIL-STD-202C, method 202B.

Initially, the connectors were subjected to three shocks, each one-half sine wave of 30 g peak for 11 milliseconds, parallel to each connector axis.

After the initial shock tests, the test specimen was subjected to three shocks, each one-half sine wave of 125 g peak for 6 milliseconds, parallel to each connector axis.

During each shock test, the connectors were wired in series, and a current of 0.1 ampere flowed through the test circuit. The connector contact chatter was monitored.

d. Thermal Shock. The connectors were subjected to thermal shock conditions in accordance with Standard MIL-STD-202C, method 102A, condition A, except for low temperature extreme was minus 20° C instead of minus 55° C. Condition A is defined as follows:

Step	Temperature °C	Time (Minutes)
1	85^{+3}_{-0}	30
2	25^{+10}_{-5}	10 to 15
3	-55^{+0}_{-3}	30
4	25^{+0}_{-5}	10 to 15

After the above test, the specimen was subjected to five continuous cycles of temperature change in accordance with Standard MIL-STD-202C, method 102A, condition C. Condition C is defined as follows:

Step	Temperature °C	Time (Minutes)
1	-65^{+0}_{-5}	30
2	25^{+10}_{-5}	10 to 15
3	125^{+3}_{-0}	30
4	25^{+10}_{-5}	10 to 15

The contact resistance of the connectors was measured before and after each thermal shock test in accordance with the requirements of paragraph D. 1. b. (See figure 3.) Results of the thermal shock test are outlined in appendix A.

e. Salt Spray. The connectors were subjected to a 20 percent salt spray test for 96 hours in accordance with Standard MIL-STD-202C, method 101B, condition A. The test was conducted as follows:

The specimen was supported from the bottom of the chamber and positioned to ensure a uniform exposure. Temperature in the exposure zone was maintained at 95 $^{+2}_{-3}$°F (35$^{+1.1}_{-1.7}$ °C). A 20 percent atomized salt solution was introduced into the chamber with atomization of approximately 3 quarts of solution per 10 cubic feet of box volume. Exposure to these conditions was 96 hours.

The contact resistance of the connectors was measured before and after submission to the test conditions in accordance with procedure paragraph D. 1. b. See figure 3 and appendix B for test schematic and test results, respectively.

f. Gas Seal Test. The sample was suspended in a desiccator (corrosion chamber). The desiccator and sample assembly

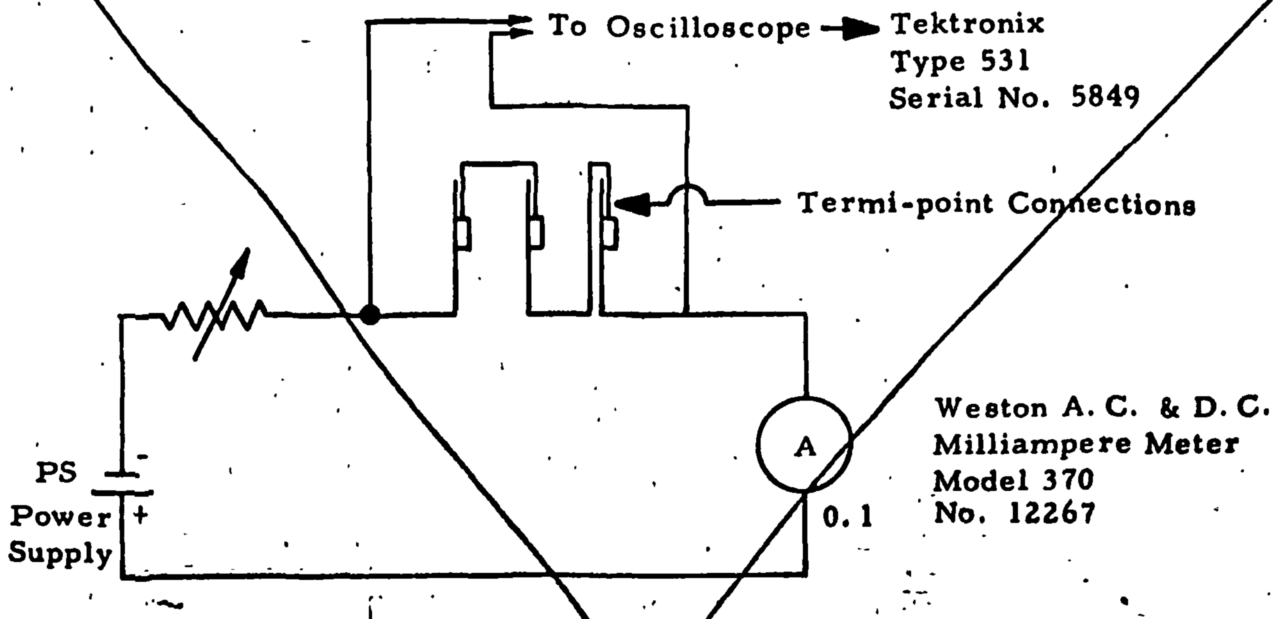


Figure 2. Contact Chatter

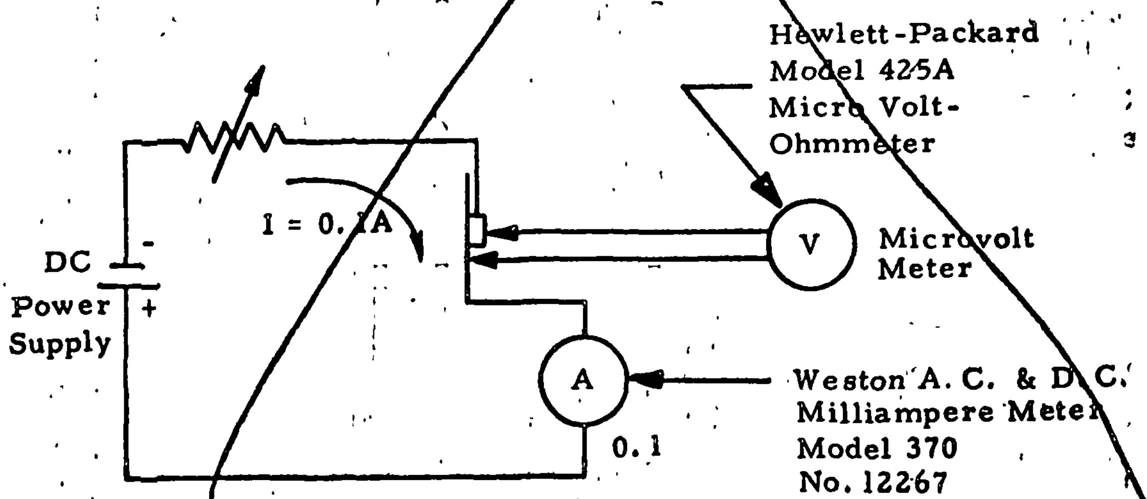


Figure 3. Contact Resistance

were purged thoroughly with hydrogen sulfide (H_2S) bottled gas for five minutes. The flow of hydrogen sulfide was then regulated to 15 bubbles per minute for the remainder of 24 hours. See figure 4. Figure 5 shows the Termi-point connectors after the test. See appendix C for the results of the gas seal test.

g. Humidity. The connectors were subjected to ten days of humidity conditions in accordance with Standard MIL-STD-202C, method 106B, figure 106-1 conditions. A typical cycle was as follows:

The sample was initially conditioned in an oven at 50°C with uncontrolled humidity for a 24-hour period, then lowered to room temperature (25°C) and maintained for 2 hours. Initial measurements were made on the sample at the end of this conditioning period. The sample temperature was then increased from room temperature to 65°C with 90 to 98 percent relative humidity over a period of 2 1/2 hours and maintained at that point for a period of 3 hours. From this point the sample was cycled to room temperature and 80 to 98 percent relative humidity, then to 65°C, 90 to 98 percent relative humidity and maintained for 3 hours, this portion of the test requiring 8 hours. The sample was then lowered to room temperature and 80 to 98 percent relative humidity over a period of 2 1/2 hours and maintained at 25°C for 1 1/2 hours, after which final measurements were made. The sample was then taken to minus 10°C, held there for 3 hours, and returned to room ambient temperature and uncontrolled humidity. The specimen was then vibrated at room temperature for 15 minutes using simple harmonic motion having an amplitude of 0.03 inch, the frequency being varied uniformly between the approximate limits of 10 and 55 cps. The specimen was then returned to 25°C and 90 to 98 percent relative humidity and maintained at these controlled conditions between cycles. Ten such cycles were performed. Figure 6 shows a typical test specimen, appendix D provides the test results.

VI. STATISTICAL ANALYSIS

The statistical analysis applies only to the following tests:

1. Thermal Shock.

2. Salt Spray.

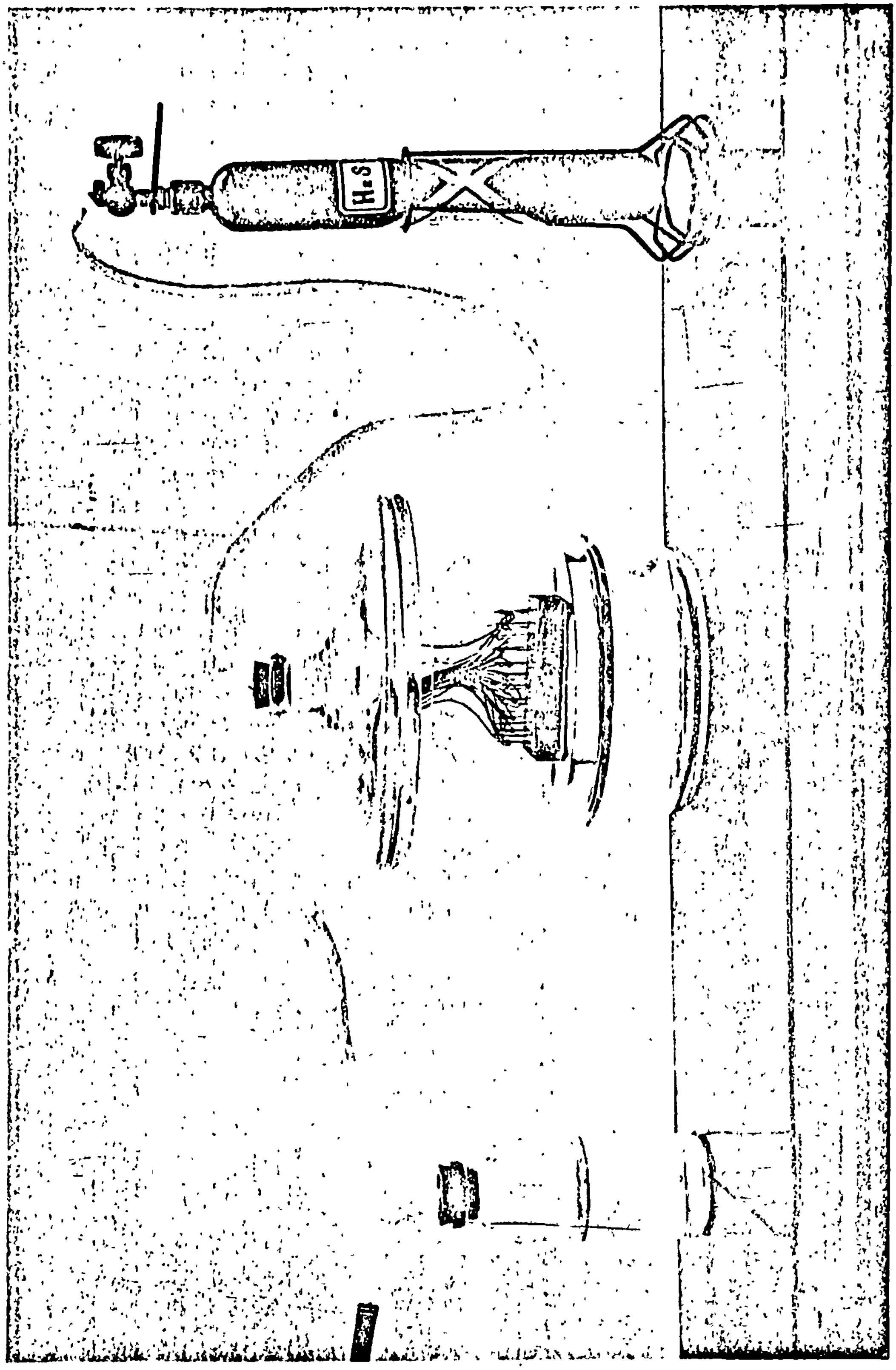


Figure 4. Termi-Point Gas Seal Test Setup

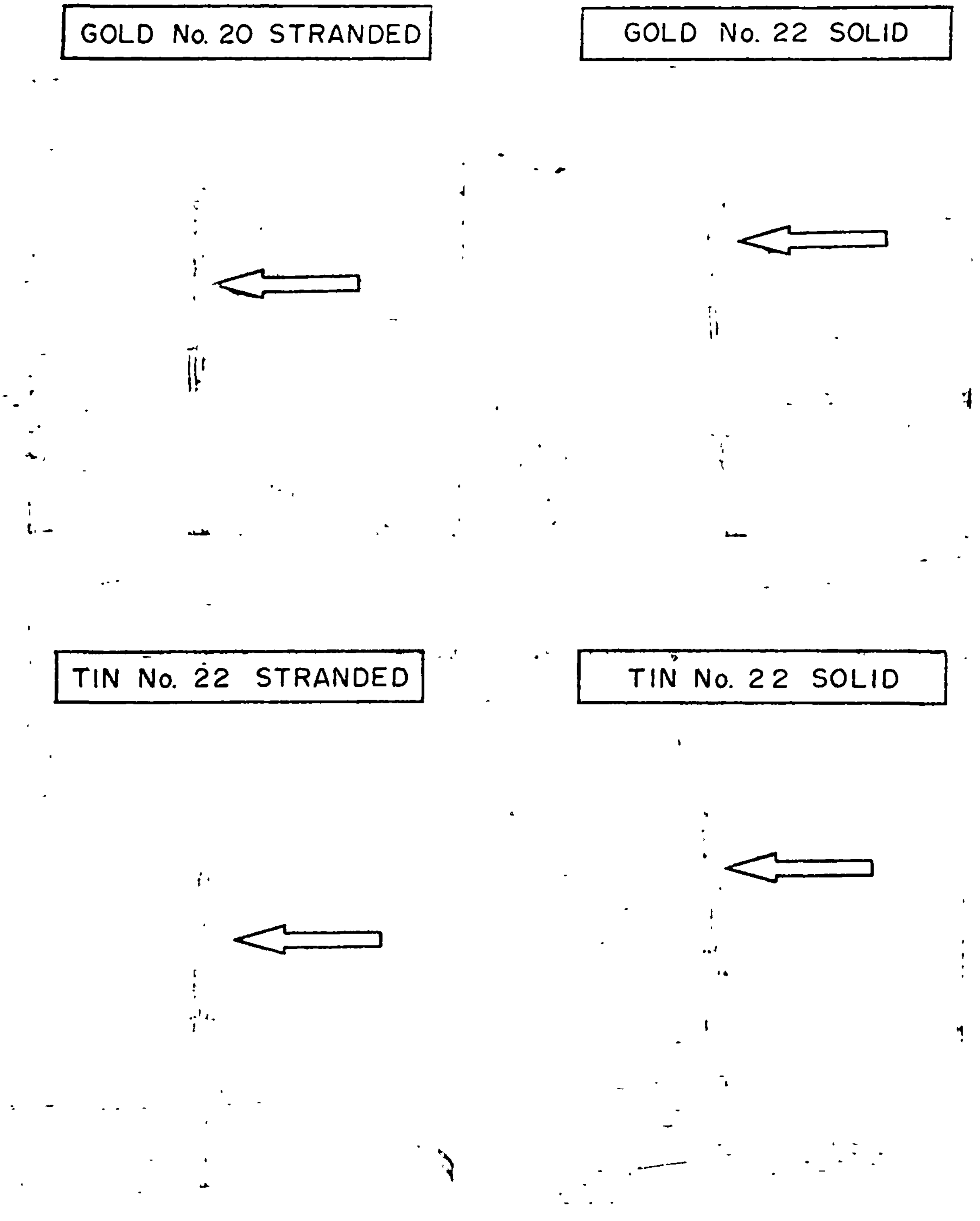


Figure 5. Termi-Point Connections After the Gas Leak Test. (Arrows Indicate the Location of the Termi-points ~~During~~ During the Test)

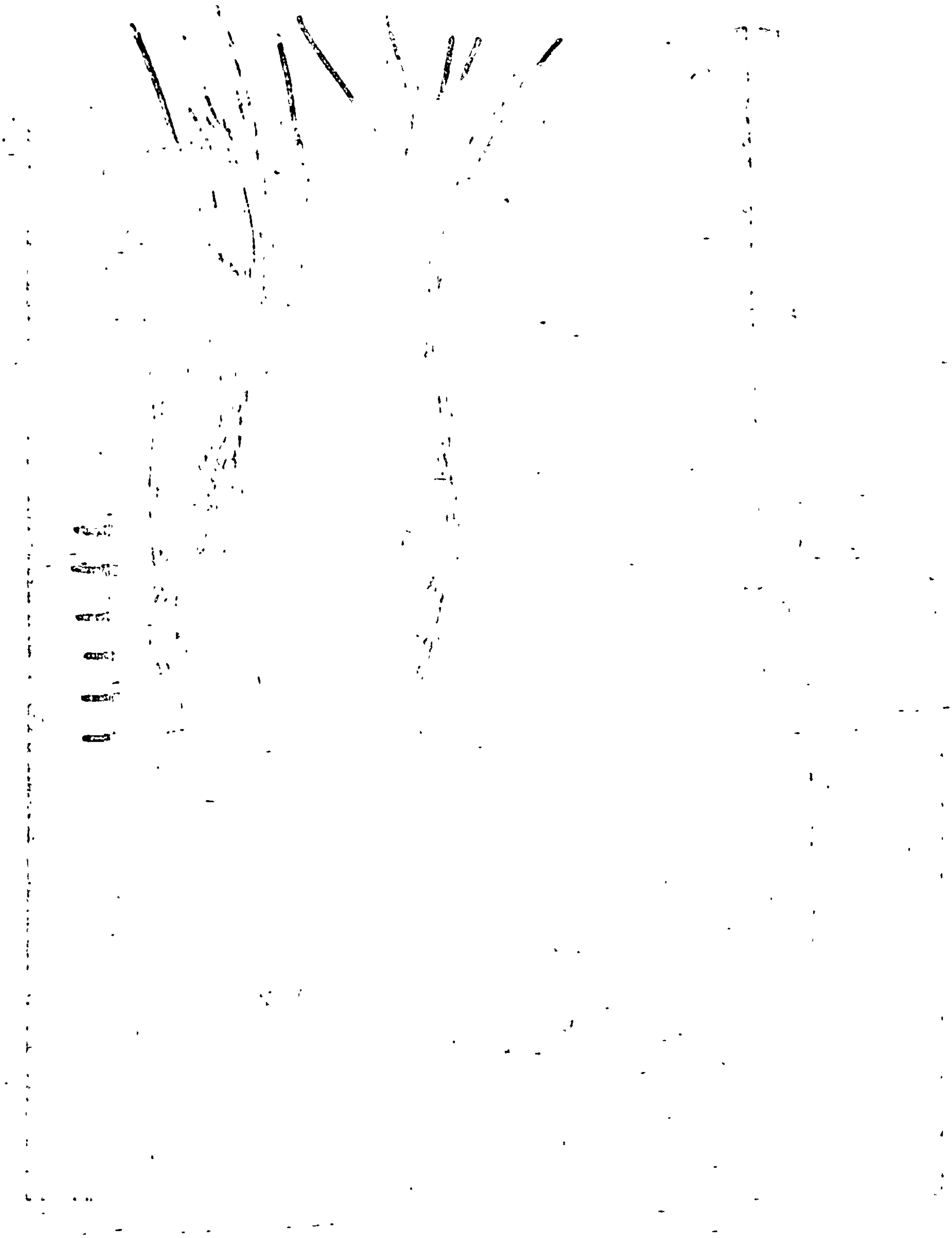


Figure 6. Typical Test Specimen

3. Humidity.

4. Gas Seal.

In these tests three parameters were measured:

1. Contact Resistance.

2. Retention Force.

3. Clip Stripping Force.

The first parameter, contact resistance, was measured before and after each of the tests. Retention force and clip stripping force were measured after the tests.

As indicated in Section II, "Design of Experiment", the overall sample was designed so it was possible to obtain comparative data from subsamples within the overall sample. The data sheets show the breakdown of the samples. For each sample the mean of the test characteristic was computed and entered under $\overline{X}$. The significance between the $\overline{X}$'s was then computed.

The hypothesis used was:

Null hypothesis: $\overline{X}_1 = \overline{X}_2$ where $\overline{X}_1$ and $\overline{X}_2$ are different permutations of the same characteristic. For example, $\overline{X}_1$ could be the average contact resistance of a sample before a certain test and $\overline{X}_2$ the average contact resistance after the test. By accepting the null hypothesis we are saying there is no significant difference between the two averages. The level of significance used was 5 percent.

In addition to pretest and posttest comparisons, comparisons were made between other parameters such as wire size, plating material, and wire type -- both pretest and posttest measurements being compared. The data sheets indicate the comparisons and results of significance tests.

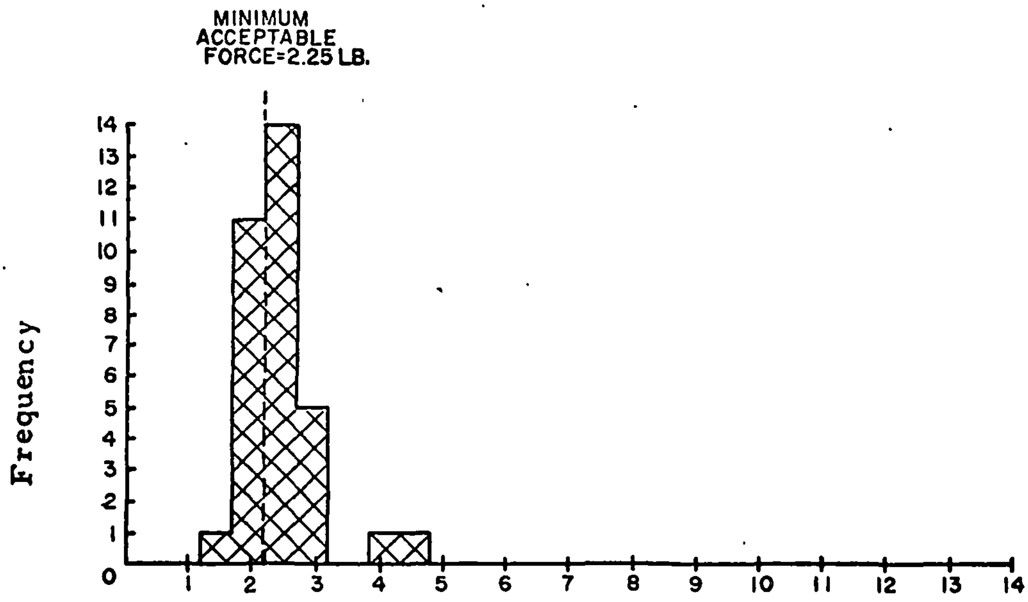
VII. TEST RESULTS AND DATA ANALYSIS

The test results and subsequent data analysis are tabulated in appendices A through D. In most cases, the "Z" statistic was used to determine if a significant difference between conditions existed.

The data are arranged such that Z values in the right hand column represent the calculated Z for a comparison between test conditions, i.e., pretest and posttest values. Immediately beneath the items being compared is another Z, the value of which is located by reading horizontally across the table. This is a Z value for a comparison between test items, i.e., gold clips versus tinned clips, etc. The calculated Z values listed in the data tables are compared with a Z value for a one-tailed test of significance obtained from a standard table. The Z value used in this report is 1.645, which is the critical value of Z for a one-tailed test at the 95 percent confidence level. If the calculated value exceeds this value (Z = 1.645), then there is said to be a significant difference between the items being compared.

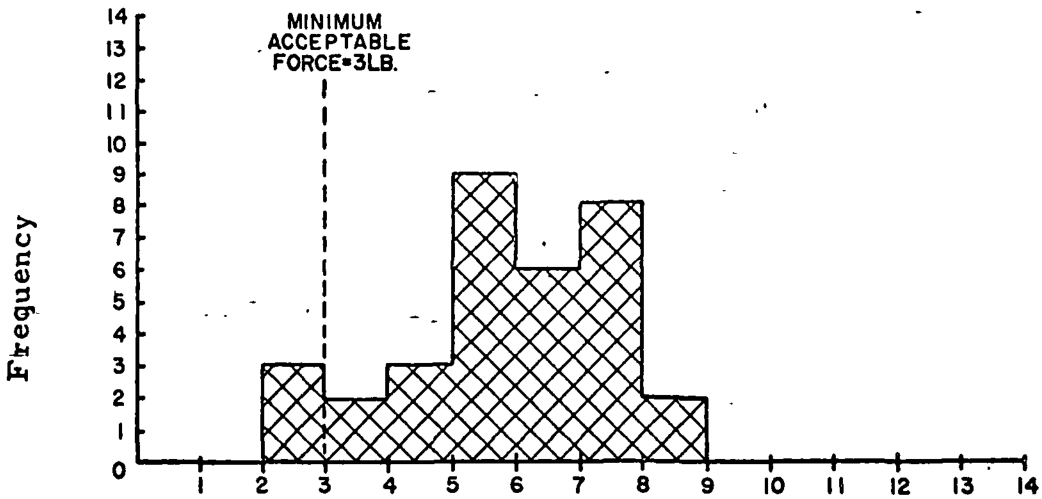
The experiment plan was set up to allow a determination of which clip surface treatment, gold-plated or tinned, was superior. Observation of appendices A through D reveals that there is a significant difference between the two treatments at a five percent level. In almost every case there is a significant difference between gold-plated and tinned clips. In general, the tinned clips exhibited a higher contact resistance, which would normally be undesirable, but they also exhibited significantly higher characteristic clip retention forces as shown in figures 7 through 12. This is desirable from a mechanical stability standpoint. This attribute, however, is offset somewhat by a larger variance, which is objectionable. Environmental conditioning did not appear to affect one type of surface treatment more than the other, although all terminations exhibited reduced clip retention forces after thermal shock conditioning. This is probably due to annealing of the materials and a consequent stress relaxation resulting in lower compression of the wire by the clip. Note that after exposure to thermal shock, 12 of a sample of 33 gold clip terminations did not meet minimum requirements as established by the manufacturer. In addition, 3 of a sample of 33 tinned clips did not meet minimum requirements.

A comparison of the solid and stranded wires used in these tests showed that both humidity and salt spray conditioning caused significant



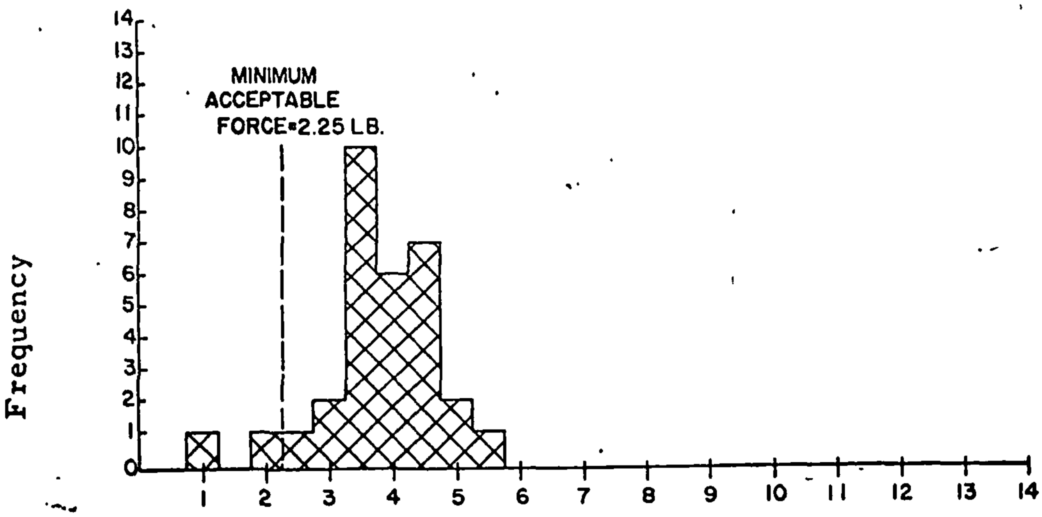
Retention Force - Pounds

Figure 7. Distribution of Retention Force of Gold Clips AfterThermal Shock Conditioning



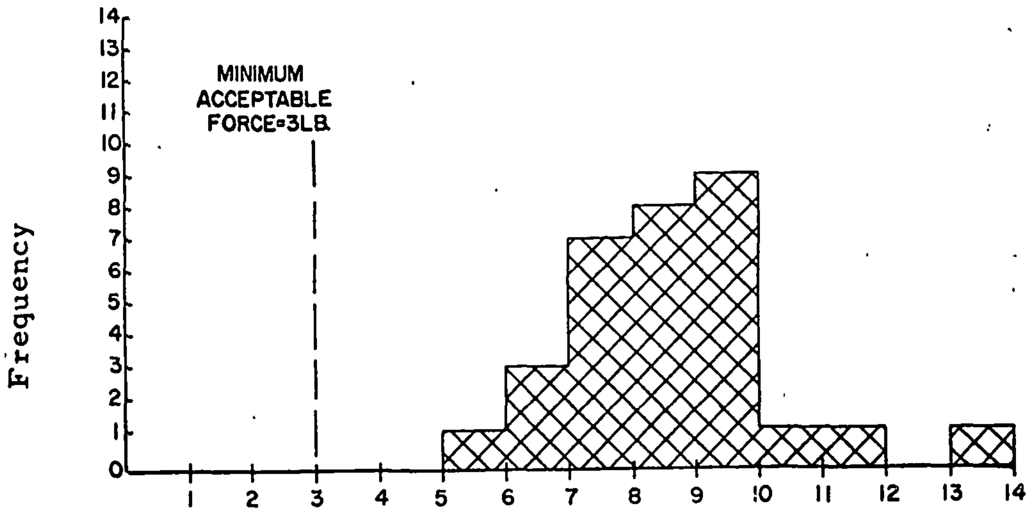
Retention Force - Pounds

Figure 8. Distribution of Retention Force of Tinned Clips After Thermal Shock Conditioning



Retention Force - Pounds

Figure 9. Distribution of Retention Force of Gold Clips After Humidity Conditioning



Retention Force - Pounds

Figure 10. Distribution of Retention Force of Tinned Clips After Humidity Conditioning

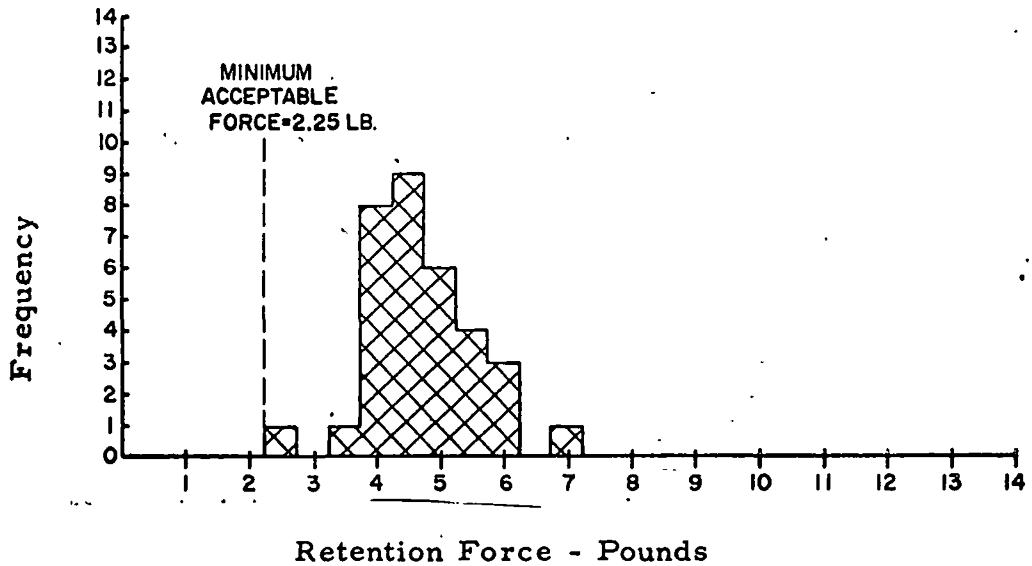


Figure 11. Distribution of Retention Force of Gold Clips After Salt Spray Conditioning

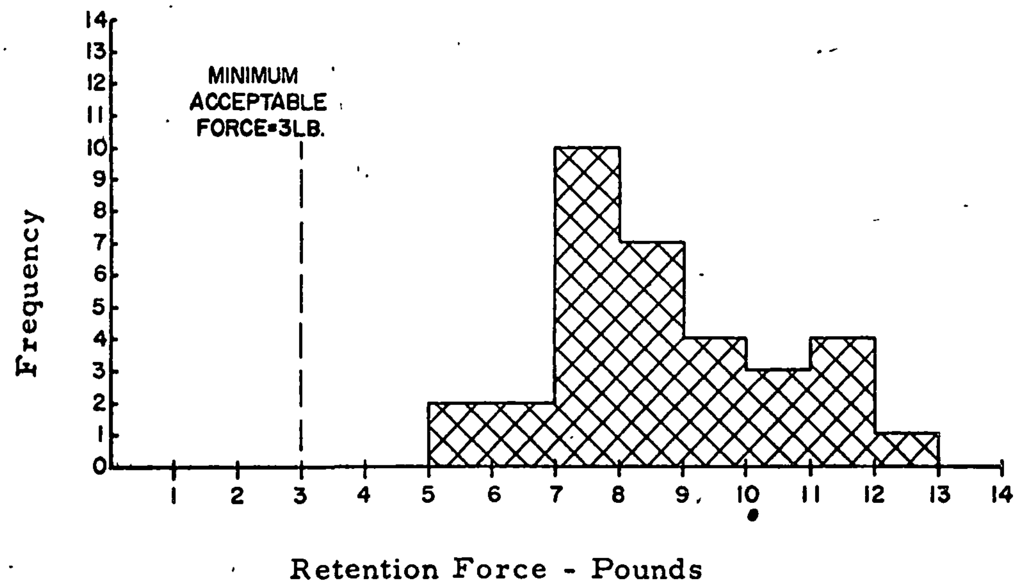


Figure 12. Distribution of Retention Force of Tinned Clips After Salt Spray Conditioning

increases in the contact resistance of connections made with solid wire. The stranded wire, in general, appeared to be somewhat more desirable due to less contact resistance change.

As cited by the manufacturer of Termi-points, stranded wire is usually more vibration resistant than solid wire. However, no failures of either solid or stranded wire were detected during vibration testing.

Although the larger wire sizes of both stranded and solid wire possessed similar slip retention forces, for the smallest gauge (AWG 26) tested, the stranded wire exhibited a consistently higher stripping force. From the appendices and data charts it can be seen that, in general, the clip retention force of all three wire sizes tested is approximately the same. However, there is a definite decrease in clip stripping force as the wire size decreases, i.e., from 22 AWG to 26 AWG. This is to be expected since lower compressive forces are exerted with smaller diameter wires.

Environmental conditioning results were not consistent, due in part to the use of small sample sizes. The effects of the conditioning, discussed in previous paragraph, can be summed up as follows:

In general, the contact resistance increased as a result of conditioning. The effect of conditioning was statistically significant at the 95 percent level in several cases, the most notable of which is salt spray. Thermal shock reduced the retention force of the clips considerably. This is characteristic of terminations which depend upon compression and tension forces for their stability. No catastrophic failures were noted during vibration nor were any intermittent failures detected by the monitoring instrumentation.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Evaluation of the test results indicates that the Termi-point connections are capable of withstanding the adverse environments to which they were subjected~~. These~~ environments however did not simulate all ground support equipment environments. Therefore, each particular proposed application of Termi-point should be reviewed carefully with regard to use environment.

In general, each individual application should be studied separately.

The low value of stripping strength, when compared with competitive interconnection techniques, is certainly a major disadvantage of the Termi-point. However, the maintainability aspects of the Termi-point offers an advantage unattainable in competing devices and should be considered in preprototype and prototype models where extensive engineering changes are contemplated. In dense connection areas the maintainability attribute is also lost due to the inaccessibility of the individual terminals.

Although Termi-points were designed to serve as connections for a whole spectrum of wire types and uses, this is virtually impossible. Based on the tests performed it is recommended that:

(a) Tinned clips be used as opposed to gold-plated clips

(b) No. 24 gauge stranded wire be used.

The results of this report should not be construed as an approval of the use of Termi-point connections as a reliable interconnection method.

APPENDIX A
THERMAL SHOCK TEST

CHARACTERISTIC CONTACT RESISTANCE (10^{-5} OHMS)

n	Sample Description	Pretest X	Pretest S^2	Posttest $\overline{X}$	Posttest S^2	Z
132	All variations of specimens	17.8	51.3	17.1	29.9	1.1
66	Gold clips and posts	14.1	49.6	14.9	33.9	0.7
66	Tinned clips and posts	21.8	35.2	19.3	19.0	2.8
	Z	6.7		4.9		
72	Stranded Wire } Gold and tinned clips and terminal posts	17.3	44.8	16.5	27.0	0.8
60	Solid Wire } Gold and tinned clips and terminal posts	18.8	71.5	17.9	29.4	0.6
	Z	1.1		1.5		
24	#22 Wire } Gold and tinned clips and terminal posts, Stranded Wire	18.0	41.6	15.8	44.2	1.2
24	#24 Wire	18.5	62.2	16.0	11.1	1.5
24	#26 Wire	15.4	28.6	17.6	26.2	1.5
24	#22 Wire } Gold and tinned clips and terminal posts, Solid Wire	22.5	75.4	17.8	55.0	1.9
24	#24 Wire	14.5	44.1	17.6	26.2	1.8
12	#26 Wire	19.8	62.1	18.9	15.9	0.4

APPENDIX A (Continued)

CHARACTERISTIC RETENTION FORCE (POUNDS)

n	Sample Description		Posttest $\overline{X}$	Posttest s^2
66	All variations of specimens		4.1	6.5
33	Gold posts and clips		2.5	0.33
33	Tinned clips and posts		5.7	2.8
	Z		1.2	
12	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	3.3	2.0
12	#24 Wire		4.7	5.7
12	#26 Wire		4.8	1.3
12	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	3.3	2.3
12	#24 Wire		4.5	5.4
6	#26 Wire		4.1	6.1

APPENDIX A (Continued)

CHARACTERISTIC CLIP STRIPPING FORCE (POUNDS)

n	Sample Description		Posttest $\overline{X}$	Posttest S^2
66	All variations of specimens		7.5	5.4
33	Gold clips and posts		6.8	3.4
33	Tinned clips and posts		8.3	6.5
	Z		2.7	
36	Stranded Wire	Gold and tinned clips and terminal posts	7.8	5.8
30	Solid Wire		7.2	4.9
	Z		1.0	
12	#22 Wire	<u>Stranded Wire,</u> gold and tinned clips and terminal posts	9.7	5.5
12	#24 Wire		7.7	1.5
12	#26 Wire		6.2	4.6
12	#22 Wire	<u>Solid Wire,</u> gold and tinned clips and terminal posts	8.9	1.9
12	#24 Wire		7.0	2.7
6	#26 Wire		4.2	0.6

APPENDIX B
SALT SPRAY TEST

CHARACTERISTIC CONTACT RESISTANCE (10^{-5} OHMS)

n	Sample Description		Pretest X	Pretest S^2	Posttest $\overline{X}$	Posttest S^2	Z
41	All variations of specimens		15.8	26.9	21.68	52.27	4.23
19	Gold clips and posts		14.2	14.1	19.18	82.58	2.22
22	Tin clips and posts		18.7	11.2	23.41	39.74	3.03
	Z		4		2.605		
23	Stranded Wire	Gold and tinned clips and terminal posts	16.1	21.2	19.13	40.03	1.85
18	Solid Wire	Gold and tinned clips and terminal posts	17.1	30.6	24.94	51.11	3.69
	Z		0.8		2.605		
8	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	12.5	39.5	17.88	27.55	1.88
7	#24 Wire	Stranded Wire - Gold and tinned clips and terminal posts	16.1	9.8	20.57	58.29	1.44
8	#26 Wire	Stranded Wire - Gold and tinned clips and terminal posts	15.3	15.5	19.13	44.41	1.42
7	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	17.3	63.5	27.0	92.33	2.05
7	#24 Wire	Solid Wire - Gold and tinned clips and terminal posts	16.3	10.4	23.14	54.48	2.25
4	#26 Wire	Solid Wire - Gold and tinned clips and terminal posts	18.0	11.2	24.5	14.33	2.56

APPENDIX B (Continued)

CHARACTERISTIC CONTACT RETENTION (POUNDS)

n	Sample Description		Posttest $\overline{X}$	Posttest S^2
66	All variations of specimens		6.5	5.4
33	Gold clips and posts		4.7	0.8
33	Tinned clips and posts		8.4	3.0
	Z		10.9	
36	Stranded Wire	Gold and tinned clips and terminal posts	6.8	6.1
30	Solid Wire	Gold and tinned clips and terminal posts	6.3	4.6
	Z		0.9	
12	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	6.9	6.3
12	#24 Wire	Stranded Wire - Gold and tinned clips and terminal posts	6.5	6.0
12	#26 Wire	Stranded Wire - Gold and tinned clips and terminal posts	6.9	7.0
12	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	6.3	7.1
12	#24 Wire	Solid Wire - Gold and tinned clips and terminal posts	6.3	3.3
6	#26 Wire	Solid Wire - Gold and tinned clips and terminal posts	6.4	3.4

APPENDIX B (Continued)

CHARACTERISTIC STRIPPING FORCE (POUNDS)

n	Sample Description		Posttest	
			$\overline{X}$	s^2
58	All variations of specimens		8.7	4.5
29	Gold clips and posts		8.1	4.1
29	Tinned clips and posts		9.3	4.1
	Z		2.3	
32	Stranded Wire	Gold and tinned clips and terminal posts	7.6	2.7
26	Solid Wire		8.8	0.1
	Z		1.3	
12	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	9.9	2.9
10	#24 Wire		8.0	3.5
10	#26 Wire		7.7	7.3
11	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	9.1	2.3
11	#24 Wire		8.7	0.6
4	#26 Wire		5.4	0.2

APPENDIX C
GAS SEAL TEST

CONTACT RESISTANCE (10^{-5} OHMS)

n	Sample Description		Pretest X	Pretest S^2	Posttest $\overline{X}$	Posttest S^2	Z
44	All variations of specimens		33.11	152.94	33.68	353.7	0.168
22	Gold clips and posts		41.86	116.6	41.25	513.3	1.097
22	Tin clips and posts		24.36	36.15	26.73	120.97	0.884
	Z		6.73		2.73		
24	Stranded	Gold and tinned clips and terminal posts	33.46	163.13	37.14	556.22	0.672
20	Solid		32.7	148.33	29.8	118.8	0.792
	Z		0.20		0.81		
8	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	32.38	81.7	45.0	829.4	1.18
8	#24 Wire		31.0	140.57	38.86	598.8	0.818
8	#26 Wire		37.0	291.14	26.43	160.62	1.44
8	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	32.0	217.14	34.22	97.44	0.355
8	#24 Wire		33.75	134.21	29.86	146.81	0.657
4	#26 Wire		32.0	114.67	19.75	5.58	2.24

APPENDIX C (Continued)

CHARACTERISTIC CONTACT RETENTION (POUNDS)

n	Sample Description	Posttest $\overline{X}$	Posttest S^2
20	All variations of specimens	4.4	4.21
9	Gold clips and posts	3.0	0.375
11	Tin clips and posts	5.5	2.273
	Z	1.71	
20	Stranded		
8	#22 Wire (Stranded Wire - Gold and tinned clips and terminal posts)	4.0	0.714
8	#24 Wire (Stranded Wire - Gold and tinned clips and terminal posts)	4.125	4.27
4	#26 Wire (Stranded Wire - Gold and tinned clips and terminal posts)	5.75	4.58

APPENDIX D
HUMIDITY TEST

CHARACTERISTIC CONTACT RESISTANCE (10^{-5} OHMS)

n	Sample Description		Pretest		Posttest		
			X	S^2	$\overline{X}$	S^2	Z
66	All variations of specimens		16.4	25.4	18.2	34.6	1.9
33	Gold clips and posts		14.5	26.6	17.2	51.6	1.7
30	Tinned clips and posts		18.3	17.4	19.1	17.3	0.7
	Z		3.2		1.3		
36	Stranded Wire	Gold and tinned clips and terminal posts	16.6	28.5	16.9	35.0	0.2
30	Solid Wire	Gold and tinned clips and terminal posts	16.2	22.3	19.6	31.1	2.3
	Z		0.3		1.9		
12	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	20.2	38.9	19.8	17.4	0.2
12	#24 Wire	Stranded Wire - Gold and tinned clips and terminal posts	15.1	8.8	16.9	40.2	0.9
12	#26 Wire	Stranded Wire - Gold and tinned clips and terminal posts	14.3	20.4	14.1	36.2	0.9
12	#22 Wire	Solid Wire - gold and tinned clips and terminal posts	15.8	27.2	21.0	14.5	2.9
12	#24 Wire	Solid Wire - gold and tinned clips and terminal posts	16.7	25.6	18.6	58.4	0.2
6	#26 Wire	Solid Wire - gold and tinned clips and terminal posts	16.2	12.1	19.0	12.4	0.7

APPENDIX D (Continued)

CONTACT RETENTION FORCE (POUNDS)

n	Sample Description		Posttest $\overline{X}$	Posttest S^2
62	All variations of samples		6.1	6.8
31	Gold clips and posts		3.8	0.8
31	Tinned clips and posts		8.1	4.5
	Z		10.5	
34	Stranded Wire		5.6	8.0
28	Solid Wire		5.9	5.5
	Z		0.5	
11	#22 Wire	<u>Stranded Wire</u> - Gold and tinned clips and terminal posts	5.8	4.4
11	#24 Wire		5.7	14.9
12	#26 Wire		6.2	6.3
12	#22 Wire	<u>Solid Wire</u> - Gold and tinned clips and terminal posts	6.0	4.3
10	#24 Wire		6.4	6.2
6	#26 Wire		6.8	8.2

APPENDIX D (Continued)

CHARACTERISTIC STRIPPING FORCE (POUNDS)

n	Sample Description		Posttest $\overline{X}$	Posttest s^2
62	All variations of specimens		7.8	8.9
31	Gold clips and posts		7.4	11.5
31	Tinned clips and posts		8.3	11.4
	Z		1.0	
34	Stranded Wire	Gold and tinned clips and terminal posts	6.5	12.9
28	Solid Wire		8.3	9.9
	Z		2.1	
11	#22 Wire	Stranded Wire - Gold and tinned clips and terminal posts	9.3	12.6
11	#24 Wire		4.5	6.7
12	#26 Wire		6.9	9.3
12	#22 Wire	Solid Wire - Gold and tinned clips and terminal posts	10.0	11.2
10	#24 Wire		9.5	5.7
6	#26 Wire		5.5	1.5

APPENDIX E

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June 1, 1966 IN-R-QUAL-66-28

APPROVAL

AN EVALUATION OF TERMI-POINT CONNECTORS

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

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